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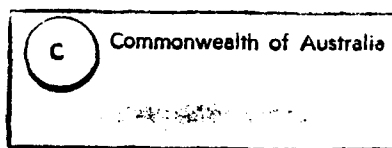
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**Visits by
Nuclear-powered Warships
to Australian Ports**

Report on Radiation Monitoring During 1991

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**Canberra, Australia
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VISITS BY NUCLEAR-POWERED WARSHIPS TO AUSTRALIAN PORTS

Report on Radiation Monitoring During 1991

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SUMMARY

Visits were made by five Nuclear-powered Warships (NPW) of the United States Navy to Australian ports in 1991 as follows:

Port	Ship	Dates
HMAS STIRLING	USS LOUISVILLE	7-12 March
Western Australia	USS CHICAGO	13-18 March
	USS ARKANSAS	15-19 October
Brisbane	USS CAVALLA	4-7 July
Queensland	USS ARKANSAS	29 October - 2 November
	USS PASADENA	4-9 December
Hobart	USS ARKANSAS	23-25 October

The Commonwealth Government requires that a radiation monitoring program be carried out in association with such visits to detect any release of radioactivity to the port or its environs.

This report presents a summary of the objectives and requirements of the NPW radiation monitoring program, describes the implementation of the program for the visits during 1991 and records the results of radiation measurements taken in the ports visited.

No releases of radioactive material were detected, nor were any radiation measurements recorded in excess of background levels of ionising radiation, either during or subsequent to these visits.

PART I — GENERAL

INTRODUCTION

1. Visits were made by five Nuclear-powered Warships (NPW) of the United States Navy to Australian ports in 1991. The USS LOUISVILLE, USS CHICAGO and USS ARKANSAS visited HMAS STIRLING, Western Australia. The USS ARKANSAS visited Hobart, Tasmania. The USS CAVALLA, USS ARKANSAS and USS PASADENA visited Brisbane, Queensland. The Commonwealth Government requires that a radiation monitoring program be carried out in association with such visits to detect any release of radioactivity to the port or its environs or any increase in external radiation levels above that due to natural background.

2. This report presents a summary of the objectives and requirements of the NPW radiation monitoring program, describes the implementation of the program for the visits during 1991 and records the results of radiation measurements taken.

THE RADIATION MONITORING PROGRAM

3. The requirements for the monitoring program are laid down in *Environmental Radiation Monitoring During Visits of Nuclear Powered Warships to Australian Ports - Requirements, Arrangements and Procedures*, Department of Defence, May 1988. These requirements were previously published in the *Report and Guidelines on Environmental Radiation Monitoring During Visits to Australian Ports by Nuclear Powered Warships*, Department of Science and Environment, September 1979.

4. The monitoring program has two main components:

- a. environmental monitoring, designed to detect the release of any radioactive material (eg waste) to the environment; and
- b. direct radiation monitoring, designed to provide warning of any malfunction of the reactor of an NPW while in port, which might lead to a release of radioactivity.

Environmental Monitoring

5. The environmental radiation monitoring program is intended to provide assurance that there has been no infringement of Australian public health standards because of the release of radioactive material from the waste control and retention systems of a visiting NPW.

6. The relevant Australian public health standards are those endorsed by the National Health and Medical Research Council in 1980 (*Recommended Radiation Protection Standards for Individuals Exposed to Ionising Radiation*, AGPS, 1981). These standards relate to permissible ionising radiation doses received by individuals from both external radiation sources and from the intake of radionuclides in air, water and foodstuffs.

7. **Internal radiation.** Internal radiation exposure of individuals could follow consumption of seafoods should these become contaminated with radioactive waste material. Accordingly, a marine environmental monitoring program is implemented to take samples of the surface layer of the bottom sediment and selected seafoods or seaweed (where available) from the vicinity of approved berths and anchorages.

8. These samples are analysed for evidence of cobalt-60 and other artificial gamma-ray emitting radionuclides known to characterise the radioactive waste likely to be held in an NPW.

9. **External radiation.** When an NPW is at an alongside berth, gamma radiation surveys are undertaken at the wharf in those areas in the vicinity of the vessel designated as free for access by the public or by port employees. Surveys are made initially on the vessel's arrival and periodically thereafter for the duration of the visit, using portable meters capable of measuring ionising radiation dose rates down to 0.1 $\mu\text{Sv h}$ full scale (1 $\mu\text{Sv h}$ is 10⁻⁶ Sv h).

10. **Thermoluminescent dosimeters.** In order to record the accumulated ionising radiation doses that might be experienced in the port environs following an accidental release of airborne radioactivity, a number of thermoluminescent dosimeters (TLDs) are exposed at selected locations. The TLDs remain in position during the period that an NPW is in port or, in the event of an accident, would remain in position until the termination of the accident. Control TLDs are exposed at the Australian Radiation Laboratory (ARL) in Melbourne and also in the port being visited, but remote from the NPW to provide a comparison with the TLDs exposed in the field. Field and control TLDs are returned to the ARL for measurement.

Direct Radiation Monitoring

11. **Early warning detection.** In order to provide early warning of an NPW reactor malfunction at an alongside berth, fixed radiation detectors are located in the vicinity of the vessel to provide continuous monitoring of gamma radiation levels. The detectors cover the range 0.01 $\mu\text{Sv/h}$ to 0.1 Sv/h with an audible alarm set to trigger at a level of 1.0 $\mu\text{Sv/h}$. A significant release of radioactivity within the vessel from the reactor would be detected and initiate an alarm.

PROGRAM IMPLEMENTATION

The Monitoring Program

12. Groups which consist of members from the Australian Nuclear Science and Technical Organisation (Ansto), the Health and Environmental authorities of the host State and the Royal Australian Navy (RAN) undertake the monitoring program. The composition of the groups varies in different ports except that the Leader of the Radiation Monitoring Group is always a radiation protection officer of Ansto.

13. The marine environmental monitoring program is a joint undertaking by the Commonwealth Department of Health, Housing and Community Services and either the State concerned or, where the berth is in a naval establishment, the RAN. The collection of samples of sediment and seafood or seaweed is carried out by State authorities or by the RAN, nominally at quarterly* intervals at approved berths and anchorages. Samples are also taken prior to and immediately after each visit. The analysis and measurement of samples is undertaken by the Department of Health, Housing and Community Services at ARL. Details of the measurement method and detection capability are presented in Appendix 1.

14. The routine sampling program may be discontinued at NPW berths and anchorages which are visited infrequently and where an adequate database has been established. When an NPW subsequently visits such a berth, samples are taken prior to and immediately after the visit and a further set of samples three months later.

Contingency Arrangements

15. Port safety organisations have been established at all ports approved for NPW visits and arrangements made so that in the event of a reactor accident they would be activated immediately. Simultaneously, radiation surveys would be initiated by Commonwealth officers in order to identify any radiation hazards. Prior to each visit, the Port Safety Organisation is brought to a state of readiness and briefings are conducted to familiarise key participants with the operational procedures and the tasks required of them in the event of an accident. Normally, an exercise is conducted prior to an NPW visit involving key members of the Port Safety Organisation.

* In practice, quarterly generally means 14 days either side of the end of the quarter. Should pre- or post-visit samples fall within two weeks of the due date for routine sampling, then the same set of samples will suffice for the routine and either pre- or post-visit samples. Authorities occasionally have difficulty in obtaining samples within these timescales.

PART II — NUCLEAR-POWERED WARSHIP VISITS IN 1991

HMAS STIRLING, GARDEN ISLAND, WESTERN AUSTRALIA

VISIT BY USS LOUISVILLE

1. USS LOUISVILLE, a nuclear-powered Los Angeles class submarine of the US Navy, visited HMAS STIRLING, Garden Island, Western Australia, during the period 7-12 March 1991, berthing at the Escort Wharf.

Radiation Monitoring

2. Throughout the visit gamma radiation levels were monitored in the vicinity of the vessel using fixed radiation detectors. Operation of the detectors commenced before the vessel's arrival and continued until its departure. Measurements were displayed and recorded on equipment located in the Naval Police Gate House which is manned continuously. In addition, measurements of gamma radiation levels were taken daily using hand-held dose-rate meters in areas around the vessel which were accessible to personnel on the base.

Results

3. The gamma radiation dose rates measured by both fixed and portable monitoring equipment for the NPW visit to HMAS STIRLING were in the range 0.07 to 0.09 $\mu\text{Sv h}^{-1}$, indicating that there was no significant increase in the external gamma radiation level above natural background.

4. TLDs were exposed at five nominated locations during the visit. Control TLDs were held in Perth and at ARL. The range of dose-rate measurements from the TLDs for the visit were as follows:

	dose-rate range ($\mu\text{Sv/h}$)
Field location	0.07 to 0.13
Perth controls	0.07 to 0.11
ARL controls	0.09

VISIT BY USS CHICAGO

5. USS CHICAGO, a nuclear-powered Los Angeles class submarine of the US Navy, visited HMAS STIRLING during the period 13-18 March 1991, berthing at the Escort Wharf.

Radiation Monitoring

6. Throughout the visit gamma radiation levels were monitored in the vicinity of the vessel using fixed radiation detectors. Operation of the detectors commenced before the vessel's arrival and continued until its departure. Measurements were displayed and recorded on equipment located in the Naval Police Gate House which is manned continuously. In addition, measurements of gamma radiation levels were taken daily using hand-held dose-rate meters in areas around the vessel which were accessible to personnel on the base.

Results

7. The gamma radiation dose rates measured by both fixed and portable monitoring equipment for the NPW visit to HMAS STIRLING were in the range 0.07 to 0.09 $\mu\text{Sv h}^{-1}$, indicating that there was no significant increase in the external gamma radiation level above natural background.

8. TLDs were exposed at five nominated locations during the visit. Control TLDs were held in Perth and at ARL. The range of dose-rate measurements from TLDs were as follows:

	dose-rate range ($\mu\text{Sv/h}$)
Field location	0.12 to 0.14
Perth controls	0.12 to 0.13
ARL controls	0.12 to 0.13

VISIT BY USS ARKANSAS

9. USS ARKANSAS, a nuclear-powered Virginia class guided missile cruiser of the US Navy, visited HMAS STIRLING during the period 15-19 October 1991, berthing at the Escort Wharf.

Radiation Monitoring

10. Throughout the visit gamma radiation levels were monitored in the vicinity of the vessel using fixed radiation detectors. Operation of the detectors commenced before the vessel's arrival and continued until its departure. Measurements were displayed and recorded on equipment located in the Naval Police Gate House which is manned continuously. In addition, measurements of gamma radiation levels were taken daily using hand-held dose-rate meters in areas around the vessel which were accessible to personnel on the base.

Results

11. The gamma radiation dose rates measured by both fixed and portable monitoring equipment for the NPW visit to HMAS STIRLING were in the range 0.05 to 0.09 $\mu\text{Sv h}^{-1}$, indicating that there was no observable increase in the external gamma radiation level above background.

12. TLDs were exposed at five nominated locations during the visit. Control TLDs were held in Perth and at ARL. The range of dose-rate measurements from the TLDs for the visit were as follows:

	dose-rate range ($\mu\text{Sv/h}$)
Field location	0.07 to 0.10
Perth controls	0.08 to 0.09
ARL controls	0.08

HOBART, TASMANIA

13. USS ARKANSAS, a nuclear-powered Virginia class guided missile cruiser of the US Navy, visited Hobart during the period 23-25 October 1991, anchoring at the approved designated location in the Derwent River.

Radiation Monitoring

14. Throughout the visit gamma radiation levels were monitored in the vicinity of the vessel using fixed radiation detectors located on the bridge of HMAS ARDENT, anchored 500 metres from USS ARKANSAS. In addition, measurements of gamma radiation levels were taken daily from police vessels using hand-held dose-rate meters.

Results

15. The gamma radiation dose rates measured by both fixed and portable monitoring equipment for the NPW visit to Hobart were $0.01 \mu\text{Sv h}^{-1}$, indicating that there was no observable increase in the external gamma radiation level above background.

16. TLDs were exposed at five nominated locations during the visit. Control TLDs were held in Hobart and at ARL. The range of dose-rate measurements from the TLDs for the visit were as follows:

	dose-rate range ($\mu\text{Sv/h}$)
Field location	0.04 to 0.05
Hobart controls	0.04 to 0.05
ARL controls	0.05

BRISBANE QUEENSLAND

VISIT BY USS CAVALLA

17. USS CAVALLA, a nuclear-powered Sturgeon class attack submarine of the US Navy, visited Brisbane during the period 4-7 July 1991, berthing at No. 1 Wharf, Fishermans Island, outboard of HMAS LABUAN.

Radiation Monitoring

18. Throughout the visit gamma radiation levels were monitored in the vicinity of the vessel using fixed radiation detectors. Operation of the detectors commenced before the vessel's arrival and continued until its departure. Measurements were displayed and recorded on equipment located on the bridge of HMAS LABUAN, approximately 20 meters from USS CAVALLA which was manned continuously. In addition, measurements of gamma radiation levels were using hand-held dose-meters in areas around the vessel which were accessible to personnel on the wharf.

Results

19. The gamma radiation dose rates measured by both fixed and portable monitoring equipment for the NPW visit to Brisbane were in the range 0.07 to $0.15 \mu\text{Sv h}^{-1}$, indicating that there was no observable increase in the external gamma radiation level above background.

20. TLDs were exposed at seven nominated locations during the visit. Control TLDs were held in Brisbane and at ARL. The range of dose-rate measurements from the TLDs for the visit were as follows:

	dose-rate range ($\mu\text{Sv/h}$)
Field location	0.05 to 0.07
Brisbane controls	0.06
ARL controls	0.06 to 0.07

VISIT BY USS ARKANSAS

21. USS ARKANSAS, a nuclear-powered Virginia class guided missile cruiser of the US Navy, visited Brisbane during the period 29 October to 2 November 1991, berthing at No. 1 Wharf, Fishermans Island.

Radiation Monitoring

22. Throughout the visit gamma radiation levels were monitored in the vicinity of the vessel using fixed radiation detectors. Operation of the detectors commenced before the vessel's arrival and continued until its departure. Measurements were displayed and recorded on equipment located in the Brisbane Port Authority building which is manned continuously. In addition, measurements of gamma radiation levels were using hand-held dose-meters in areas around the vessel which were accessible to personnel on the wharf.

Results

23. The gamma radiation dose rates measured by both fixed and portable monitoring equipment for the NPW visit to Brisbane were in the range 0.01 to 0.13 $\mu\text{Sv h}^{-1}$, indicating that there was no observable increase in the external gamma radiation level above background.

24. TLDs were exposed at seven nominated locations during the visit. Control TLDs were held in Brisbane and at ARL. The range of dose-rate measurements from the TLDs for the visit were as follows:

	dose-rate range ($\mu\text{Sv/h}$)
Field location	0.07 to 0.10
Brisbane controls	0.08 to 0.09
ARL controls	0.10

VISIT BY USS PASADENA

25. USS PASADENA, a nuclear-powered Los Angeles class attack submarine of the US Navy, visited Brisbane during the period 4-9 December 1991, berthing at No. 1 Wharf, Fishermans Island.

Radiation Monitoring

26. Throughout the visit gamma radiation levels were monitored in the vicinity of the vessel using fixed radiation detectors. Operation of the detectors commenced before the vessel's arrival and continued until its departure. Measurements were displayed and recorded on equipment located in a State Emergency Services caravan located on the wharf approximately 200 meters from USS PASADENA which was manned continuously. In addition, measurements of gamma radiation levels were using hand-held dose-meters in areas around the vessel which were accessible to personnel on the wharf.

Results

27. The gamma radiation dose rates measured by both fixed and portable monitoring equipment for the NPW visit to Brisbane were in the range 0.06 to 0.09 $\mu\text{Sv h}^{-1}$, indicating that there was no observable increase in the external gamma radiation level above background.

28. TLDs were exposed at seven nominated locations during the visit. Control TLDs were held in Brisbane and at ARL. The range of dose-rate measurements from the TLDs for the visit were as follows:

	dose-rate range ($\mu\text{Sv/h}$)
Field location	0.07 to 0.09
Brisbane controls	0.09
ARL controls	0.09

Marine Environment Monitoring

29. Marine environmental samples, appropriate to each berth visited, were collected, according to the agreed sampling program. A total of 27 samples were collected, ie eleven from the vicinity of the Escort Wharf at HMAS STIRLING, fourteen from the vicinity of the berth at Fisherman's Islands and two sediment samples from the anchorage in the Derwent River (there were no shellfish or seaweed in the vicinity of the anchorage). All samples were analysed at ARL. Certificates of analysis issued by ARL showed that no radionuclide was detected that would be characteristic of the radioactive waste associated with NPW operations.

Training

30. Ansto provided training in warship monitoring techniques during a course held during the period 30 September to 11 October 1991 which was attended by 17 RAN personnel from HMAS HUON (3), HMAS MORETON (1), HMAS STIRLING (5), HMAS COONAWARRA (1), HMAS ALBATROSS (2) and YTM BANDICOOT WALLAROO (5). HMAS STIRLING, HMAS HUON and HMAS MORETON personnel were used to assist Ansto in implementing the monitoring program.

CONCLUSIONS

31. The program of radiation monitoring and marine environmental sampling implemented for visiting NPWs during 1991 was consistent with the Commonwealth Government's requirements.

32. There was no indication of any infringement of Australian public health standards. Radiation monitoring did not detect any release of radioactive material, nor did radiation measurements indicate any value in excess of background levels of ionising radiation either during or subsequent to these visits.

MARINE ENVIRONMENTAL MONITORING

Measurement Method

1. Each sample is measured for 10 000 seconds, in a standard geometry, in a low background gamma-ray spectrometer with Ge (Li) detector. Each gamma-ray spectrum is scrutinised over the energy range of 50 to 1500 KeV for evidence of cobalt-60 and other artificial gamma-ray emitting radionuclides.

Detection Capability

2. The measurement method used has sufficient sensitivity to detect concentrations of gamma-ray emitting radionuclides in shellfish which, based upon typical intakes of shellfish, would result in no more than 1 per cent of the annual limits for members of the public as given in the 1980 recommendations of the Australian National Health and Medical Research Council *Recommended Radiation Protection Standards for Individuals Exposed to ionising Radiation* (AGPS, 1981).

3. For surface layer of bottom sediments, the measurement methods used have sufficient sensitivity to detect artificial gamma-ray emitting radionuclides at concentrations at least as low as 40 millibecquerels per gram of sediment.